File E469960
Project 4789352991

August 26, 2020

REPORT

on

Photovoltaic Rapid Shutdown Systems (QIJS)

TIGO ENERGY, INC.
CAMPBELL CA

Copyright © 2020 UL LLC

UL LLC authorizes the above named company to reproduce this Report only for purposes as described in the Conclusion, provided it is reproduced in its entirety.

DESCRIPTION

PRODUCT COVERED:

USL, CNL - PV Rapid Shutdown Systems

System Designation – "Rapid Shutdown_TS4-A-2F" and "Rapid Shutdown_TS4-A-F"

GENERAL:

This is a "High Reliability Photovoltaic Rapid Shutdown System" (PVRSS) consisting of the combination of Tigo components with specific inverters evaluated for compliance with requirements in NEC clause 690.12. The System has met the requirements in the UL 1741 Certifications Requirement Decision dated April 2, 2015 - section 31A, "High Reliability Equipment and Systems – functional safety", and can be labeled accordingly.

Each system consists of inverter models, Tigo transmitter(s) and Tigo DC attenuators which have been evaluated for use together, and which are intended for field installation.

This report documents the combinations of equipment that were tested together to show compliance to the UL 1741 Certification Requirement Decision regarding evaluation of PVRS Systems and Equipment.

USL - Evaluated to the requirements of the Standard for Safety for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources, UL 1741, Second Edition, Dated January 28, 2010, with revisions through September 7, 2016. Including the Certification Requirement Decision dated April 2, 2015, for the evaluation of PVRS Systems and Equipment.

CNL - Additionally evaluated to CAN/CSA C22.2 No. 107.1-3, "General Use Power Supplies." Reaffirmed 2011.

*"Certifications issued under this file section are valid until **July 22, 2022."**

A Listed PVRS System in this file will consist of:

- A Tigo DC Attenuator.
- A Tigo or other PLC transmitter.
- A third party inverter which may contain a transmitter (component), the combination of which has been found to be compliant with the Certification Requirement Decision dated April 2, 2015.

Tested combinations of equipment are shown in Table 1.

This report documents the combinations of equipment that were tested together to show compliance to the UL 1741 Certification Requirement Decision regarding evaluation of PVRS Systems and Equipment.

Table 1
Photovoltaic rapid shutdown system (PVRSS: Rapid Shutdown_TS4-A-2F **and TS4-A-F**

Subassembly Equipment	System Ratings
DC PVRSS shutdown: Listed(QIJW), Tigo model TS4-A-2F(484-00252-12)	Two Inputs: 16-80VDC per input, 15 Amp Output: 32-160VDC, 15A max cont. output current, 1000W max per module, **1000VDC/1500VDC** maximum system voltage, (limited by inverter DC system voltage).
DC PVRSS shutdown: **Listed(QIJW), Tigo TS4-A-F(481-00252-32)**	**Single Input: 16-80Vdc, 15A** **Output: 16-80Vdc, 15A max cont. output current, 700W, 1000VDC/1500VDC maximum system voltage, (limited by inverter DC system voltage).**
DC PVRSS shutdown: **Listed(QIJW), Tigo TS4-A-F(482-00252-32)**	**Single Input: 16-80Vdc, 15A** **Output: 16-80Vdc, 15A max cont. output current, 650W, 1000VDC/1500VDC maximum system voltage, (limited by inverter DC system voltage).**
DC PVRSS shutdown: **Listed(QIJW), Tigo TS4-A-F(483-00252-32)**	**Single Input: 16-80Vdc, 15A** **Output: 16-80Vdc, 15A max cont. output current, 600W, 1000VDC/1500VDC maximum system voltage, (limited by inverter DC system voltage).**
Listed(QIJW), Tigo model RSS Transmitters (PLC) **These Transmitters are provided with a UL 50 Compliant Listed enclosure and are suitable for installation in the field.** One of the following may be provided: **492-00000-10 or** 492-00000-51 (RSS Transmitter Din Rail, Single RSS Core, Outdoor), **492-00000-20 or** 492-00000-52 (RSS Transmitter Din Rail, Dual RSS Core, Outdoor) See Footnote +	12 Vdc, 1 A

*

Table 1 (continued)
Photovoltaic rapid shutdown system (PVRSS: Rapid Shutdown_TS4-A-2F and TS4-A-F

Subassembly Equipment	System Ratings
INVERTERS - NRTL Listed:	--
Ningbo Ginlong Technologies Co., Ltd	
RHI-1P5K-HVES-5G	500Vdc
RHI-1P6K-HVES-5G	500Vdc
RHI-1P7K-HVES-5G	500Vdc
RHI-1P7.6K-HVES-5G	500Vdc
RHI-1P8K-HVES-5G	500Vdc
RHI-1P9K-HVES-5G	500Vdc
RHI-1P10K-HVES-5G	500Vdc
Solis-66k-US-F-SW	1000Vdc
Solis-66k-US-LSW	1000Vdc
Solis-60k-US-F-SW	1000Vdc
Solis-60k-US-F-LSW	1000Vdc
Solis-50k-US-F-SW	1000Vdc
Solis-50k-US-SW	1000Vdc
Solis-50k-US-F-LSW	1000Vdc
Solis-50k-US-LSW	1000Vdc
Solis-40k-US-F-SW	1000Vdc
Solis-36k-US-F-SW	1000Vdc
Solis-40k-US-SW	1000Vdc
Solis-36k-US-SW	1000Vdc
Solis-30k-US-SW	1000Vdc
Solis-25k-US-SW	1000Vdc
Solis-40k-US-F-LSW	1000Vdc
Solis-36k-US-F-LSW	1000Vdc
Solis-40k-US-LSW	1000Vdc
Solis-36k-US-LSW	1000Vdc
Solis-30k-US-LSW	1000Vdc
Solis-25k-US-LSW	1000Vdc
Solis-1P10k-4G-US	600Vdc
Solis-1P9k-4G-US	600Vdc
Solis-1P8k-4G-US	600Vdc
Solis-1P7.6k-4G-US	600Vdc
Solis-1P7k-4G-US	600Vdc
Solis-1P6k-4G-US	600Vdc
Solis-1P6k2-4G-US	600Vdc
Solis-1P5k-4G-US	600Vdc
Solis-1P4.6k-4G-US	600Vdc
Solis-1P4k-4G-US	600Vdc
Solis-1P3.6k-4G-US	600Vdc
Solis-1P3k-4G-US	600Vdc
Solis-1P2.5k-4G-US	600Vdc
Solis-100K-5G-US #	1000 VDC
Solis-90K-5G-US	1000 VDC
Solis-80K-5G-US	1000 VDC
Solis-75K-5G-US	1000 VDC
# Tested with internal Tigo Transmitter Model Din Rail No. 490-00000-20.	

*

Table 1 (continued)
Photovoltaic rapid shutdown system (PVRSS: Rapid Shutdown_TS4-A-2F and TS4-A-F

INVERTERS – NRTL Listed:	
Canadian Solar, Inc. (CSI)	**1000Vdc**
CSI-66KTL-GS-B (66kW)	**1000Vdc**
CSI-60KTL-GS-B (60kW)	**1000Vdc**
CSI-50KTL-GS-B (50Kw)	**1000Vdc**
CSI-50KTL-GS-FLB (50Kw)	**1000Vdc**
CSI-66k-T480GL01-UB	**1000Vdc**
CSI-60K-T480GL01-UB	**1000Vdc**
CSI-50K-T480GL01-UB	**1000Vdc**
CSI-40KTL-GS-B (40Kw)	**1000Vdc**
CSI-40KTL-GS-FLB (40Kw)	**1000Vdc**
CSI-36KTL-GS-FLB (36Kw)	**1000Vdc**
CSI-30KTL-GS-FLB (30Kw)	**1000Vdc**
CSI-25KTL-GS-FLB (25Kw)	**1000Vdc**
CSI-40K-T480GL01-UB	**1000Vdc**
CSI-36K-T480GL01-UB	**1000Vdc**
CSI-30K-T480GL01-UB	**1000Vdc**
CSI-25K-T480GL01-UB	**1000Vdc**
CSI-75K-T480GL02-U	**1000Vdc**
CSI-80K-T480GL02-U	**1000Vdc**
CSI-90K-T480GL02-U	**1000Vdc**
CSI-100K-T480GL02-U	**1000Vdc**
# Tested with internal Tigo Transmitter Model Din Rail No. 490-00000-20.	
Portable Solar, LLC (Sol Ark)	
Sol-Ark-12k-P	**500Vdc**
Sol-Ark-9k-48-ST	**500Vdc**
Sol-Ark-8k-48-ST	**500Vdc**
Sol-Ark-5k-48-ST	**500Vdc**
Delta -Commercial,	
M80U_120,_121,_122 (80kW) #	**1000Vdc**
M60U_120,_121,_122 (60kW) #	**1000Vdc**
M42U_120,_121,_122 (42kW) #	**1000Vdc**
M36U_120,_121,_122 (36kW) #	**1000Vdc**
# Delta-Commercial inverters may operate with or without the use of the inverter's internal 12Vdc power supply as a source for the Tigo Transmitter.	

*

Table 1 (continued)
Photovoltaic rapid shutdown system (PVRSS: Rapid Shutdown_TS4-A-2F and TS4-A-F

INVERTERS:	--
Delta (Residential)	
M10-TL-US	600Vdc
M8-TL-US	600Vdc
M6-TL-US	600Vdc
M5-TL-US	600Vdc
M4-TL-US	600Vdc
E8-TL-US	600Vdc
E6-TL-US	600Vdc
LG Electronics Inc.	
D007KEEN261 (7.6kW)	600Vdc
A005KEEN261 (5kW)	600Vdc
Growatt New Energy Technology Co., Ltd.	
4000MTLP-US (4kW)	600Vdc
6000MTLP-US (5kW)	600Vdc
5000MTLP-US (6kW)	600Vdc
7000MTLP-US (7kW)	600Vdc
7600MTLP-US (7.6kW)	600Vdc
9000MTLP-US (8kW)	600Vdc
8000MTLP-US (9kW)	600Vdc
10000MTLP-US (10kW)	600Vdc
33000TL3-US (33kW)	1000Vdc
36000TL3-US (36kW)	1000Vdc
40000TL3-US (40kW)	1000Vdc
MIN 3000TL-XH-US	**600Vdc**
MIN 3800TL-XH-US	**600Vdc**
MIN 5000TL-XH-US	**600Vdc**
MIN 6000TL-XH-US	**600Vdc**
MIN 7600TL-XH-US	**600Vdc**
MIN 3000TL-XA-US	**600Vdc**
MIN 3800TL-XA-US	**600Vdc**
MIN 5000TL-XA-US	**600Vdc**
MIN 6000TL-XA-US	**600Vdc**
MIN 7600TL-XA-US	**600Vdc**
MIN 8200TL-XH-US	**600Vdc**
MIN 9000TL-XH-US	**600Vdc**
MIN 10000TL-XH-US	**600Vdc**
MIN 11400TL-XH-US	**600Vdc**
MIN 8200TL-XA-US	**600Vdc**
MIN 9000TL-XA-US	**600Vdc**
MIN 10000TL-XA-US	**600Vdc**
MIN 11400TL-XA-US	**600Vdc**
SPH3000TL BL-US	**550VDC**
SPH3600TL BL-US	**550VDC**

Table 1 (continued)
Photovoltaic rapid shutdown system (PVRSS: Rapid Shutdown_TS4-A-2F and TS4-A-F

INVERTERS:	--
SPH4000TL BL-US	550VDC
SPH4600TL BL-US	550VDC
SPH5000TL BL-US	550VDC
SPH6000TL BL-US	550VDC
SMA Solar Technology,	
STP62 US-41, #	1000Vdc
STP50 US-41, #	1000Vdc
STP33 US-41, #	1000Vdc
SB 7.7 SP-US-41 #	600Vdc
SB 7.7 TP-US-41 #	600Vdc
SB 7.0 SP-US-41 #	600Vdc
SB 7.0 TP-US-41 #	600Vdc
SB 6.0 SP-US-41 #	600Vdc
SB 6.0 TP-US-41 #	600Vdc
SB 5.0 SP-US-41 #	600Vdc
SB 5.0 TP-US-41 #	600Vdc
SB 3.8 SP-US-41 #	600Vdc
SB 3.8 TP-US-41 #	600Vdc
SB 3.0 SP-US-41 #	600Vdc
SB 3.0 TP-US-41 #	600Vdc
# with or without Tigo Transmitter. The SMA inverter may be provided with an internal Sunspec transmitter evaluated with the Tigo device for compatibility.	
CE+T Energy Solutions, Inc	
30C3	**1000Vdc**
NingBO Deye Inverter Technology Co., Ltd	
SUN-8K-SG01LP1-US	600Vdc
SUN-7.6K-SG01LP1-US	600Vdc
SUN-5K-SG01LP1-US	600Vdc

Table 1 (continued)
Photovoltaic rapid shutdown system (PVRSS: Rapid Shutdown_TS4-A-2F and TS4-A-F

INVERTERS:	--
SolaX Power Co. Ltd.	
A1-Hybrid-8.6-US	500Vdc
A1-Hybrid-7.6-US	500Vdc
A1-Hybrid-7.0-US	500Vdc
A1-Hybrid-6.0-US	500Vdc
A1-Fit-8.6-US	500Vdc
A1-Fit-7.6-US	500Vdc
A1-Fit-7.0-US	500Vdc
A1-Fit-6.0-US	500Vdc
Hanwha Q-Cells	500Vdc
Q.HOME+ HYB-G1-6.0	500Vdc
Q.HOME+ HYB-G1-7.0	500Vdc
Q.HOME+ HYB-G1-7.6	500Vdc
Q.HOME+ HYB-G1-8.6	500Vdc
Q.HOME+ AC-G1-6.0	500Vdc
Q.HOME+ AC-G1-7.0	500Vdc
Q.HOME+ AC-G1-7.6	500Vdc
Q.HOME+ AC-G1-8.6	500Vdc
Fronius,	
Symo Advanced 24.0-3 (24kW) #	1000Vdc
Symo Advanced 20.0-3 (20kW) #	1000Vdc
Symo Advanced 15.0-3 (15kW) #	1000Vdc
Symo Advanced 12.0-3 (12kW) #	1000Vdc
Symo Advanced 10.0-3 (10kW) #	1000Vdc
# w/o Tigo RSS Transmitter, inverter may use internal inverter PLC transmitter	
ABB	
PVS-60-TL-US	1000Vdc
UNO-DM-3.3-TL-PLUS-US	600Vdc
UNO-DM-3.8-TL-PLUS-US	600Vdc
UNO-DM-4.6-TL-PLUS-US	600Vdc
UNO-DM-5.0-TL-PLUS-US	600Vdc
UNO-DM-6.0-TL-PLUS-US	600Vdc
UNO-DM-3.3-TL-PLUS-US-Q	600Vdc
UNO-DM-3.8-TL-PLUS-US-Q	600Vdc
UNO-DM-4.6-TL-PLUS-US-Q	600Vdc
UNO-DM-5.0-TL-PLUS-US-Q	600Vdc
UNO-DM-6.0-TL-PLUS-US-Q	600Vdc

*

Table 1 (continued)
Photovoltaic rapid shutdown system (PVRSS: Rapid Shutdown_TS4-A-2F and TS4-A-F

Chint Power	
CPS SCA20KTL-DO-R/US-480 #	**1000Vdc**
CPS SCA25KTL-DO/US-480 #	**1000Vdc**
CPS SCA50KTL-DO/US-480 #	**1000Vdc**
CPS SCA60KTL-DO/US-480 #	**1000Vdc**
# w/o Tigo RSS Transmitter, inverter may use internal inverter PLC transmitter.	
SOLECTRIA,	
PVI 60TL (60kW) #	**1000Vdc**
PVI 50TL (50kW) #	**1000Vdc**
PVI 25TL-480-R #	**1000Vdc**
PVI 20TL-480-R #	**1000Vdc**
# w/o Tigo RSS Transmitter, inverter may use internal inverter PLC transmitter.	
SUNGROW POWER SUPPLY CO., LTD	
SG60CX-US #	**1000Vdc**
SG36CX-US	**1000Vdc**
# Tested with Internal Tigo Transmitter Model PCBA, Dual RSS Core, Part No.490-00100-20	
+ Transmitters - R/C(QIJW2) : **490-00100-10 or 490-00100-51 (RSS Transmitter PCBA, Single RSS Core),** **490-00100-20 or 490-00100-52 (RSS Transmitter PCBA, Dual RSS Core),** **490-00000-10 or 490-00000-51 (RSS Transmitter Din Rail, Single RSS Core),** **490-00000-20 or 490-00000-52 (RSS Transmitter Din Rail, Dual RSS Core),** **These transmitters utilize the same circuit design as the "outdoor" Listed (QIJW) transmitter, but they are not provided with a compliant enclosure or field wiring connections. They are not provided separately for use in systems and cannot be added to an already Listed product in the field. They may be included as an integral component in other Listed products shown in the tables, which should be addressed in the operating instructions provided with the Listed product.**	

*

TECHNICAL CONSIDERATIONS (NOT FOR FIELD REPRESENTATIVE'S USE):

This report covers the combination of Tigo components with specific inverters evaluated as a PV rapid shutdown system. The system consists of the inverter, the Tigo Power Line Communicator (PLC)transmitter and the Tigo models indicated in the table above, which are designed for field installation together by qualified personnel and meet the requirements of NEC 690.12.

Only the ability of the completed systems to comply with PV Rapid Shutdown System requirements under the Certification Requirement Decision dated April 2, 2015 was evaluated. Any other functionality of the system components in combination with each other, or interactions between system components has not been evaluated.

Testing was carried out with a string of PV modules fitted with the TS4-A-2F, and a string fitted with TS4-A-F. The system uses the PLC transmitter to communicate the "keep alive" signal. .

The inverters provided as part of the system may or may not be certified by UL. Because of the lack of control on inverters certified by other NRTLs, additional follow up testing is described in the Appendix pages.

The attenuation for the system occurs when the AC branch circuit protection or other disconnecting device, typically located in the panelboard (load center) is opened.
This cuts power to the 1) PLC transmitter which provides the keep-alive signal to the DC Attenuators. It is critical that the transmitter be part of the same AC circuit controlled by the PVRSS shut down procedure (PVRSS initiator).

MARKINGS:

Enhanced Listing Mark –

This report covers the following CCNs and the Listing mark should include product identities as indicated in the Listing report.

[X] QIJW/7 – Listed Component, High Reliability Photovoltaic Rapid Shutdown System Equipment
[X] QIJS/7 – High Reliability Photovoltaic Rapid Shutdown System, Limited to specific equipment indicated in the Listing and report.

In the above cases, the word "Photovoltaic" may be abbreviated "PV."

All recognized or Listed components of the PVRSS system are marked as indicated in the Listing reports.

The AC disconnect device to initiate Rapid Shutdown shall be provided with a permanent marking including the following wording or the equivalent:

"PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN."

"OPERATION OF THIS SYSTEM DISCONNECT DEVICE WILL RESULT IN SHUTDOWN OF THE PHOTOVOLTAIC ARRAY IN ADDITION TO INTERRUPTION OF SYSTEM POWER"

The term "PHOTOVOLTAIC" may be replaced with "PV."

The plaque or directory shall be reflective, with all letters capitalized and having a minimum height of 9.5 mm (3/8 in.) in white on red background.

Operating and Installation Instructions –

The operating and installation instructions shall:

Describe the equipment installation, including specifically: • Assembly, and mounting instructions including mounting orientation, securement. • Grounding means.
Explain equipment markings, including specifically: • Symbols. • Controls. • The environmental enclosure type.
Identify and describe interconnections with: • The PV Rapid Shutdown System. • Auxiliary and accessory equipment including power supply.
Explain the operation of the equipment.
The installation instructions should indicate that the National Electrical Code, ANSI/NFPA 70 wiring methods are to be used.
The installation instructions should include that the CSA Standard CAN/CSA C22.1 wiring methods are to be used.
The installation instructions for a PVRSE or PVRSS shall include the following or the equivalent, “Attention – The AC Disconnect of this system is considered the actuator as well as the indicator for the PVRSS operation” and “AC-DC Power Supply MUST be on the same AC branch circuit as the inverter to meet rapid shutdown requirement.” In a prominent location near the actuator device the end use installation shall be provided with a permanent marking including the following wording: 'PHOTOVOLTAIC SYSTEM EQUIPPED WITH RAPID SHUTDOWN' The term “PHOTOVOLTAIC” may be replaced with “PV.”

System : Rapid Shutdown_TS4-A-2F **AND TS4-A-F**

General – The System consists of the following required parts used together.

1. Photovoltaic DC Attenuator – Listed (QIJW/7) Tigo Energy Inc., Models as indicated in the above Table 1.

2. Transmitter – Listed (QIJW/7), Tigo Power Line Communication (PLC) Models as indicated in the table above. The transmitter is required to be powered from an AC or DC source directly controlled by the PVRSS initiator.

3. Inverter – NRTL Listed types, evaluated to UL 1741 2nd Edition, see Table 1 for inclusive list of combinations.